

AUTOMATIC ATTITUDE ACTIVATION AND EFFICIENCY: THE FOURTH HORSEMAN OF AUTOMATICITY

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Fazio, Sanbonmatsu, Powell, and Kardes (1986) were the first to demonstrate that participants evaluate target adjectives more quickly when these adjectives are primed by attitude object primes (positive or negative nouns) that are evaluatively congruent as compared to affectively incongruent primes. On the basis of these findings, Fazio et al. argued that attitudes stored in memory become automatically active upon the mere presentation of the attitude object. The argument that automatic processes are responsible for these affective/evaluative priming effects is primarily based on studies that have manipulated the interval between the onset of the prime and the onset of the target. In addition to these studies, and in line with a conditional approach of automaticity (Bargh, 1989), we have advocated a more fine-grained analysis of the characteristics of the automatic processes responsible for the affective priming effect. In the present study, the efficiency of these processes was examined. Participants performed a standard affective priming task while simultaneously reciting a series of digits. The extent to which this secondary memory load task depleted cognitive capacities was manipulated over three levels on a within-subjects basis. Results showed that response latencies were shorter on affectively congruent trials as compared to affectively incongruent trials. This effect was not mediated by the memory load manipulation. An identical pattern of results emerged in the error data. The results indicate that affective priming effects are based on relatively efficient processes.

One of the important research domains within the attitude literature concerns the relation between attitude and behaviour, and more specifically the nature of the processes by which attitudes can guide behaviour. This entails the study of the processes that are responsible for the activation of the relevant attitude from memory, as well as of the processes by which the

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activated attitude influences subsequent behaviour toward the attitude object. Within this research domain, there has traditionally been a lot of emphasis on effortful, deliberate processes such as those highlighted in Ajzen and Fishbein's (1980) theory of reasoned action. According to these authors, people arrive at an attitude toward a specific behavioural alternative through a rational analysis of its likely consequences and their desirability. The resulting attitude and perceptions of normative social norms are weighed and integrated in a behavioural intention.

Recently, however, there has been a growing interest in another class of attitude-behaviour processes which are of a spontaneous and automatic nature. Fazio (1986), for example, has advanced a process model concerning the attitude-behaviour relationship which is solely based on such automatic processes. According to this attitude accessibility model, an attitude should be viewed as an association in memory between the representation of an attitude object and its summary evaluation (in terms of the positive-negative dimension) (Fazio, 1995). The presentation of the attitude object results in the activation of its memory representation and immediately leads to the automatic activation of the related attitude. Once activated, this attitude serves as a filter that influences subsequent object-relevant information processing; it acts upon the perception of the attitude object and the immediate situation in which it is encountered (see Fazio, Roskos-Ewoldsen, & Powell, 1994, for a general discussion on this issue). These perceptions subsequently influence behaviour toward the attitude object. This route can unwind in a totally automatic fashion and is very functional in the sense that it increases the ease, speed, and quality of decision making (Fazio, Blascovich, & Driscoll, 1992).

In his description of the multiple processes by which attitudes can guide behaviour, Fazio (1990) distinguishes between these two general processing modes; i.e., deliberate processes involving careful consideration of the available information and spontaneous processes based on the automatic activation of the relevant attitude. According to this model, the standard processing mode is the automatic one, unless people are motivated to engage in deliberate processing *and* are given sufficient opportunity to do so. It will be evident that a prerequisite for this automatic attitude-to-behaviour route is that (a) the person has a pre-existing attitude about the attitude object in the form of a summary evaluation (positive/negative, good/bad) which is associated with the memory representation of the attitude object, and that (b) this general attitude/evaluation can be automatically activated upon the presentation of the attitude object.

In order to obtain experimental evidence for the automatic attitude activation hypothesis, Fazio, Sanbonmatsu, Powell, and Kardes (1986) employed a modified version of the standard sequential priming paradigm

(Neely, 1991) in which the affective/evaluative relation of the prime-target pairs was manipulated. This procedure has become known as the *affective priming paradigm* (Hermans, De Houwer, & Eelen, 1994). In a prototypical affective priming study, positive or negative prime stimuli (words or pictures) are presented for 200 milliseconds and are followed by a positive or negative target stimulus after an inter stimulus interval of 100 milliseconds, resulting in a Stimulus Onset Asynchrony of 300 ms (SOA; i.e., the interval between the onset of the prime and the onset of the target). Results show that the time needed to evaluate these target stimuli as either "positive" or "negative" is significantly shorter when prime and target share the same valence (positive-positive or negative-negative; affectively congruent) as compared to when prime and target are of opposite valence (positive-negative or negative-positive; affectively incongruent) (Bargh, Chaiken, Govender, & Pratto, 1992; Fazio et al., 1986; Hermans et al., 1994).

The generality of this affective priming effect is now well-established. Affective priming effects have been demonstrated for attitude objects as diverse as *words* (Bargh et al., 1992; Chaiken & Bargh, 1993; Fazio et al., 1986; Hermans et al., 1994; Klauer, Rossnagel, & Musch, 1997), *nonsense words* for which the affective meaning was only recently learned (De Houwer, Hermans, & Eelen, 1998), *simple line drawings* (Giner-Sorolla, Garcia, & Bargh, 1999), *complex real life colour pictures* (Fazio, Jackson, Dunton, & Williams, 1995; Hermans et al., 1994), and *odours* (Hermans, Baeyens, & Eelen, 1998). Moreover, affective priming effects have been demonstrated using different types of tasks, such as *evaluative categorization* (e.g., Bargh et al., 1992; Fazio et al., 1986; Hermans et al., 1994; Klauer, Rossnagel, & Musch, 1997), *lexical decisions* (Wentura, 1997), and *pronunciation* (Bargh, Chaiken, Raymond, & Hymes, 1996; Hermans, 1996, Experiment 9; Hermans et al., 1994, in press; but see Klauer, 1998).

The fact that the results obtained by the affective priming paradigm provide empirical evidence for the idea that attitudes can be automatically activated, is based on the argument that the short stimulus onset asynchrony (usually SOA 300 ms) which is typically employed in affective priming research is too brief an interval to permit participants to develop an active expectancy or conscious response strategies, as such conscious and flexible expectancies would require at least 500 ms to develop and to influence responses in priming tasks (Neely, 1977; Posner & Snyder, 1975). Hence, Bargh et al. (1992, p. 894) argued that "given an SOA of 300 ms, then, if presentation of an attitude object prime influences the response time to a target adjective, it can only be attributed to an automatic, unintentional activation of the corresponding attitude" (p. 894).

Additional evidence for the automatic character stems from studies in which the SOA was manipulated (Fazio et al., 1986, Experiment 2; Hermans et al., 1994, Experiment 1). In these studies for half of the trials, the interval between the onset of the prime and the onset of the target was 300 ms, whereas for the other half the SOA was 1000 ms. If the priming effects observed at SOA 300 are not based on automatic processes, but are the product of consciously controlled processes, one would expect stronger or at least similar results if participants are provided more time to process the prime-target relation, because controlled processes are generally assumed to be more time-consuming than automatic processes. Nevertheless, although in both studies strong affective congruency effects could be observed at SOA 300, no effects were present at the longer SOA of 1000 ms. This provides an indirect but rather strong indication of the automatic nature of the attitude activation effect. Further investigations of the time course of affective priming showed that affective priming effects are indeed based on fast-acting processes (Hermans, De Houwer, & Eelen, in press; Klauer & al., 1997; Musch & Klauer, 1997). At very short SOAs (SOA 150 ms and even SOA 0 ms) affective priming effects could be observed, while for longer SOAs (450, 1000) the effect disappeared.

Given that automatic processes have been characterized as fast, efficient, uncontrollable, unintentional, and occurring outside awareness (Johnson & Hasher, 1987), it would be tempting to attribute all these features to the process of spontaneous attitude activation on the basis of the SOA studies. Such an approach is justified within the traditional dual-mode conceptualisation of cognitive processes, which states that two separate and mutually exclusive classes of processes exist. The first (automatic processes) is characterized by the above-mentioned qualities, while the second class of conscious, controlled processes is their mirror image (slow, demanding attentional processes, controllable, intentional, and accessible to conscious introspection) (Hasher & Zacks, 1979). According to this classic dual-mode view, the different characteristics of both types of processes are assumed to co-occur. A process was characterized either by *all* features of automaticity, or by all features of controlled processing. Hence, knowledge about one feature was sufficient to infer all other characteristics.

Recent conceptions of cognitive processes however, have abandoned this binary model of cognition (see Bargh, 1989, 1992, 1996, for a general discussion on this issue). This theoretical shift was inspired by the fact that it became increasingly clear that mental processes are not exclusively automatic or exclusively controlled, but often involve combinations of each (Bargh, 1994; Kahneman & Treisman, 1984; Logan & Cowan, 1984). Since there are also no compelling theoretical reasons to assume that automatic processes are unitary in nature (Zbrodoff & Logan, 1986), Bargh (1989,

1992) advocated for a decomposition approach towards the study of automaticity. Instead of inferring one feature on the basis of another, one should perform an experimental analysis for each of the characteristics separately. It is generally agreed that the following characteristics ought to be included in such a conditional analysis: control, awareness, intention, and efficiency (Kahneman & Treisman, 1984, p. 42). These characteristics are also known as the Four Horsemen of Automaticity (Bargh, 1994). Three of them (awareness, intention and efficiency) relate to the preconditions that have or do not have to be fulfilled in order for a certain cognitive process to take place. The first characteristic (control) on the other hand, bears on the question of whether a cognitive process, once started, can be brought under voluntary control. Given our main interest in the preconditions of automatic attitude activation (Hermans, 1996; Hermans & Eelen, 1997), we will only discuss awareness, intention, and efficiency (see Pratto, 1994, for a discussion on automatic evaluation and control).

With respect to the *awareness characteristic*, Greenwald and his colleagues (Greenwald, Klinger, & Liu, 1989; Greenwald, Klinger, & Schuh, 1995) demonstrated that evaluative responses towards target words were influenced by the affective congruency between the target and subliminally presented primes. Thus, automatic attitude activation does not depend upon awareness of the activating attitude object.

The *intention characteristic* refers to the question whether automatic attitude activation requires a conscious intention to evaluate. One could argue that the task to consciously evaluate the target stimuli as either positive or negative in the standard affective priming paradigm might induce an evaluative mindset which could be a necessary precondition for the effect to occur. However, when we removed all evaluative aspects that could induce such a conscious intention to evaluate, and replaced the target evaluation task by a target pronunciation task, strong affective priming effects were still obtained (Hermans, 1996; Hermans et al., 1994). Similar effects have been reported by Bargh et al. (1996; pronunciation task) and by Wentura (1997; lexical decision task). These data demonstrate that automatic attitude activation does not depend on a conscious intention to evaluate.

The *efficiency characteristic* of automaticity refers to the extent to which a process, e.g., automatic attitude activation, demands attentional resources. To the degree that it does, the process may not be activated when the attentional demands of the situation are high. One of the central assumptions of contemporary information processing theories is that human cognitive functioning involves certain limitations. The notion of limited processing resources is probably one of the most popular metaphors. It stems from the work of Norman and Bobrow (1975), which was the first of a long series of resource theories (for recent overviews, see Pashler, 1994; Wells &

Matthews, 1994). On a functional level, the idea of limited cognitive resources can be coupled to the study of working memory. In his classical subdivision of working memory, Baddeley (1990) introduced a central processing unit, the *central executive*, which holds a supervising function over two slave systems (phonological loop and visuo-spatial sketch pad). In a more recent discussion of his model, Baddeley (1990) defines the central executive as a "supervisory attentional system" (Norman & Shallice, 1986) that administers the assignment of the limited cognitive processing resources.

Evidence for the central role of working memory with respect to the limited capacity of our cognitive system has been obtained by studies using the *concurrent memory load procedure* (see Baddeley, 1986 for an overview), which is a variant of the dual task paradigm. In this procedure, the participant is asked to recite a series of digits while simultaneously performing a second task. The extent to which the memory load task depletes the limited cognitive capacities can be manipulated by changing the length or complexity of the series of digits. The impact of the simultaneous mental load on the performance on the primary task will be more extensive as the main task requires more cognitive resources. An efficient process, i.e., a process which also operates when attentional resources are scarce, will not be as much affected, or not at all, by such a secondary task. This has led several researchers to use the concurrent memory load technique to investigate the efficiency characteristic of processes which are assumed to be automatic (e.g., *social judgments*: Andersen, Spielman, & Bargh, 1992; Bargh & Tota, 1988; *dispositional inference*: Lupfer, Clark, & Hutchinson, 1990; Winter, Uleman, & Cunniff, 1985).

In the present study, we used the concurrent memory task to assess the efficiency of automatic attitude activation. While performing a standard affective priming procedure, participants were asked to recite a series of digits aloud. The extent to which this secondary memory load task depleted cognitive capacities was manipulated over three levels on a within-subjects basis (no load, low load, high load). If automatic attitude activation is based on an efficient process, no influence of the memory manipulation is expected. If, on the other hand, this form of attitude activation is grounded in a resources-consuming process, it is predicted that in the no load condition there will be a significant affective priming effect, which will disappear or will at least be significantly weaker as the memory load increases (low load condition, high load condition). This should be evident in the reaction time data, as well as in the error data.

Method

Participants

Twenty-four first and second year psychology students (7 men, 17 woman) participated for partial fulfilment of course requirements.

Materials

Selection of the primes and targets was based on a normative study (Hermans and De Houwer, 1994), which provides affective (1 = very negative; 7 = very positive) and familiarity (1 = not familiar at all; 7 = very familiar) ratings for 740 Dutch words. Prime words were 30 nouns, of which one third was positive, one third neutral, and one third negative. The three prime types differed significantly for the affective dimension; for all three comparisons, $t(18) > 10$; $p < .001$, ($M_{\text{positive}} = 6.04$; $M_{\text{neutral}} = 4.07$; $M_{\text{negative}} = 2.01$), but did not differ significantly concerning word length (number of letters), $t(18) = 0.00$, *n.s.*, ($M_{\text{positive}} = 5.5$; $M_{\text{neutral}} = 5.5$; $M_{\text{negative}} = 5.5$), or subjective familiarity [for each of the three comparisons $t(18) < 1$, *n.s.*, ($M_{\text{positive}} = 5.17$; $M_{\text{neutral}} = 5.18$; $M_{\text{negative}} = 5.10$)]. Positive and negative primes did not differ for affective extremity¹, $t(18) = 0.251$, *n.s.*, ($M_{\text{positive}} = 2.04$; $M_{\text{negative}} = 1.99$), but both were of course affectively more extreme than the neutral primes, $t(18) > 10$, $p < .001$, ($M_{\text{neutral}} = 0.11$).

Target words were 15 positive and 15 negative adjectives. They differed significantly on the affective dimension, $t(28) = 40.68$, $p < .0001$, ($M_{\text{positive}} = 6.02$; $M_{\text{negative}} = 1.86$), but not for word length, $t(28) = 0.14$, *n.s.*, ($M_{\text{positive}} = 8.0$; $M_{\text{negative}} = 7.9$), subjective familiarity, $t(28) = 0.003$, *n.s.*, ($M_{\text{positive}} = 5.76$; $M_{\text{negative}} = 5.76$), or affective extremity, $t(28) = 1.16$, *n.s.*, ($M_{\text{positive}} = 2.02$; $M_{\text{negative}} = 2.14$).

Strings of six characters were used as *memory loads*. For the *no load condition* this was always a string consisting of six X's (X X X X X X). A string of alternating digits was used in the *low load condition* (e.g., 2 7 2 7 2 7), while for the *high load condition* a series of six digits was used of which at least five out of six were different (e.g., 4 7 5 2 8 1). For the latter condition, it was taken care of that the series did not contain an obvious rule (e.g., 1 3 5 7 9 1), that there were no more than two consecutive digits in a

¹ Affective extremity refers to the (absolute) extent to which the affective rating of a specific word deviates from the mean of the affective rating scale. For example, a word for which the affective score is -2.7 according to the Hermans and De Houwer (1994) norms, has an affective extremity of 1.3 (with "4" being the theoretical mean of these seven-point rating scales).

row (e.g., 1 2 3 4 5 6), and that the series did not include a meaningful succession of digits (e.g., 0 1 4 9 2 0). For both the low load and the high load condition, 30 different memory loads were made.

Primes, targets, and memory loads were presented in white uppercase characters (8 mm high, 5mm wide) against the black background of an SVGA computer monitor. Presentation of the stimuli was controlled by a Turbo Pascal 5.0 program operating in SVGA graphics mode. Participants responded by pressing one of the two buttons on the response box, which stopped a highly accurate Turbo Pascal timer (Bovens & Brysbaert, 1990). The experiment was run on an IBM compatible 386 computer. A Roland DR-15 microphone mounted on a microphone stand was placed in front of the participant.

Procedure

The experimenter invited the participants to take place at a distance of about 50 cm from the computer screen and provided some general information about the purpose of the study. It was explained that the experiment concerned the speed at which people are able to affectively categorize stimulus words. It was told that adjectives would be presented and that the participant's task consisted in evaluating each of these target words as quickly as possible as either positive or negative, by pressing one of the two response buttons. Each adjective would be preceded by another word (the prime), which they had to ignore because their only function was to make the task more difficult for the participant. In addition, they would have to recite a series of digits in two of the three conditions of the experiment.

The experiment consisted of 180 experimental trials, subdivided in two series of 90 trials. Within each series, there were 30 trials for each of the three memory load conditions. The order of these conditions was randomized for each of both series and each participant separately. Each trial started with the presentation of the memory load which remained on the screen until the participant pressed the space bar. In case the memory load consisted of digits (low load and high load conditions) participants had to unceasingly recite these digits out loud at a pace of about two digits per second. When they could recite the digits without errors, they had to press the space bar. In the no load condition, the participant did not have to recite anything and could start the trial by pressing the space bar at any time. For each series of thirty trials, there were 10 trials for which the interval between pressing the space bar and the actual trial was one second, 10 trials with an interval of two seconds, and 10 trials with an interval of three seconds. The order of these intervals was randomized for each series of 30 trials. Different

intervals were chosen to prevent that participants would be able to predict when the prime and target would be presented and hence adopt a strategy in reciting the digits at a tempo which would allow for a minimum of interference by the memory load task. It is important to note that during the interval before the onset of the priming trial and also during the actual priming trial, participants continued to recite the memory load out loud (low and high load conditions).

The presentation of the prime was preceded by a warning tone (1000 Hz, 200 ms). Primes were presented for 200 ms. The target word was presented 150 ms after the onset of the prime (SOA 150 ms). Due to the 50 ms overlap in the presentation of prime and target, both stimuli were presented above one another and were separated about 7 mm from each other (each 3.5 mm from the centre of the screen). For each trial it was determined randomly whether the prime would be presented below the target or vice versa, thus ensuring locational uncertainty of the target (Glaser & Glaser, 1989). The target stimulus was always underlined with a thin white line and stayed on the screen until the participant gave a response or 2000 ms elapsed. The memory load for the next trial appeared immediately after the response. Half of the participants had to press the right button for a "positive" response and the left button for a "negative" response; this order was reversed for the remaining participants.

In each block all 30 primes and 30 targets were presented. For each block, the computer program assigned primes randomly to the targets; the only restriction being that there should be equally large sets of affectively congruent (5 positive-positive, 5 negative-negative), affectively incongruent (5 positive-negative, 5 negative-positive), and control prime-target pairs (5 neutral-positive, 5 neutral-negative). This semi-randomization was done for each block and each participant separately. Participants were given the opportunity to take a brief break after each experimental block.

After the priming phase, participants were invited to express the experienced mental load for each of the three memory load conditions on a "0" (*I have found this a very easy task*) to "100" (*I have found this a very difficult task*) scale. These ratings served as a manipulation check for the memory load manipulation.

Results

Subjectively Experienced Mental Load

The data of the last question were analyzed using a 2 (Response Condition: positive button right / positive button left) x 3 (Memory Load: no load / low load / high load) ANOVA. As expected, participants experienced a significant difference in the level of mental load between the three memory load conditions, $F(2, 44) = 109.08$, $p < .00001$, $M_{\text{no load}} = 7.22$, $M_{\text{low load}} = 29.20$, $M_{\text{high load}} = 60.52$. A priori contrasts confirmed that the low load condition was experienced as more difficult than the no load condition, $t(23) = 7.42$, $p < .0001$, and in turn that the high load condition was experienced as more difficult than the low load condition, $t(23) = 8.03$, $p < .0001$. There was neither a main effect of response condition nor an interaction between response condition and memory load.

Response Latency Data

All response latencies below 200 ms or over 1500 ms were discarded from the analysis to reduce the influence of outlier responses (3.84%). Also, all trials on which an incorrect response was given (e.g., positive in stead of negative) were discarded from the analysis (7.89 %). The remaining data (88.6%) were analyzed using a 2 (Response Condition: positive button right / positive button left) x 2 (Block: first experimental block / second experimental block) x 3 (Memory Load: no load / low load / high load) x 2 (Target Valence: positive / negative) x 3 (Affective Congruence: congruent / control / incongruent) ANOVA with repeated measures for the last four variables.

The main effect of affective congruence was significant, $F(2, 44) = 3.49$, $p < .05$. A priori contrasts showed that response latencies for affectively congruent trials ($M = 538$) were significantly shorter than response latencies for affectively incongruent trials ($M = 566$), $t(23) = 2.43$, $p < .05$ ². This effect should be interpreted as mainly a facilitation effect, because the difference between congruent and control trials ($M = 560$) was significant, $t(23) = 1.97$, $p < .05$, while the difference between control trials and incongruent trials was not, $t(23) = 0.51$, *n.s.*

² Unless otherwise reported, all a priori contrasts are one-sided.

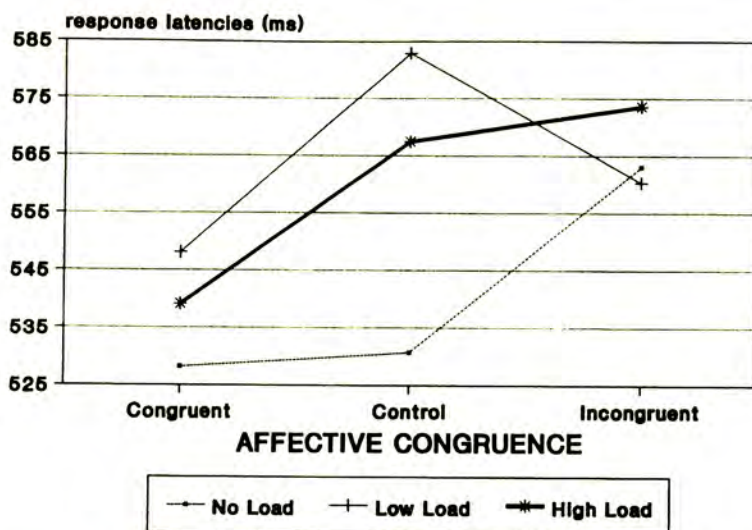


Figure 1. Mean response latencies for affectively congruent, control, and affectively incongruent trials as a function of memory load condition (no load / low load / high load).

This main effect of affective congruence did not interact with the memory load manipulation, $F(4, 88) = 1.97$, *n.s.*. Although this crucial interaction did not reach significance, because of our a priori hypotheses, a priori contrasts were calculated between congruent and incongruent trials for each of the three memory load levels separately³. For the no load condition, participants responded faster on affectively congruent trials ($M = 528$), as compared to affectively incongruent trials ($M = 563$), $t(23) = 1.99$, $p < .05$. Although the means were in the expected direction, there was no significant difference between congruent and incongruent trials in the low load condition, $M_{\text{congruent}} = 548$, $M_{\text{incongruent}} = 560$, $t(23) = 0.64$, *n.s.*. For the high load condition, the crucial comparison proved to be significant $M_{\text{congruent}} = 539$, $M_{\text{incongruent}} = 573$, $t(23) = 2.11$, $p < .05$.

Besides the main effect of affective congruence, there was a main effect of block, $F(1, 22) = 44.61$, $p < .0001$. Response latencies were generally slower in the first experimental block ($M = 603$), as compared to the second experimental block ($M = 506$), which can be attributed to an effect of practice. Also, the analyses showed an interaction between response condition and target valence, $F(1, 22) = 5.31$, $p < .05$. Participants who had

³ Because they are not important for our present research question, specific comparisons with the control pairs will not be reported.

to press the right button for a positive response, were faster on positive targets than on negative targets, while participants who had to press the right button for a negative response, were faster on negative targets as compared to positive targets. This effect is most probably due to the (right)handedness of the majority of the participants. Although mean response latencies tended to be somewhat slower for the low ($M = 564$) and high load ($M = 560$) conditions as compared to the no load condition ($M = 541$), there was no main effect of the memory load manipulation ($F < 1$).

Error Data

After outlier reduction, the mean number of trials for which a false response was given was 7.89 %. The mean number of errors was calculated for each of the cells of the design (minimum = 0; maximum = 5), and was analyzed using a 2 (Response Condition: positive button right / positive button left) $\times$ 2 (Block: first experimental block / second experimental block) $\times$ 3 (Memory Load: no load / low load / high load) $\times$ 2 (Target Valence: positive / negative) $\times$ 3 (Affective Congruence: congruent / control / incongruent) ANOVA with repeated measures for the last four variables.

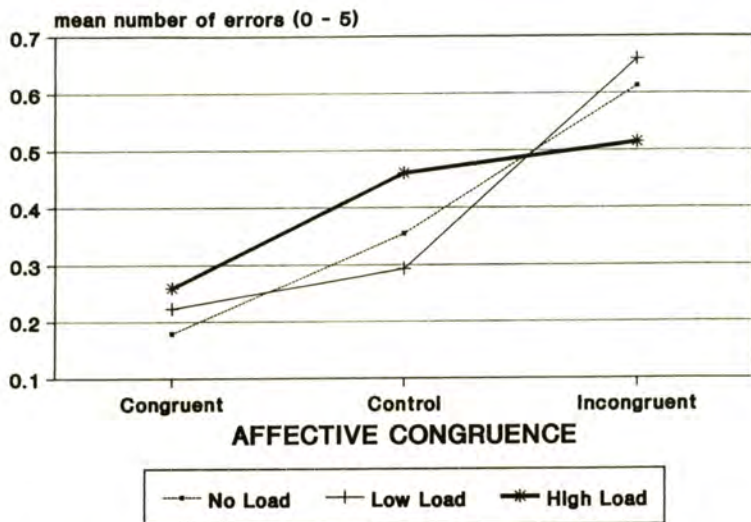


Figure 2. Mean number of errors (minimum = 0; maximum = 5) as a function of the memory load and affective congruence variables.

The analysis showed a significant main effect of affective congruence, $F(2, 44) = 5.41$, $NDf(1.11, 24.32)$, $p < .05^4$. A priori contrasts showed that there were significantly more errors on affectively incongruent trials ($M = 0.60$) than on affectively congruent trials ($M = 0.22$), $t(23) = 2.37$, $p < .05$. Control trials ($M = 0.37$) lead to more errors than congruent trials, $t(23) = 1.71$, $p = .05$, but to less errors than incongruent trials, $t(23) = 2.73$, $p < .05$. Again, the effect of affective congruence was not mediated by the memory load manipulation, $F(4, 88) = 2.43$, $NDf(1.02, 22.36)$, *n.s.*.

Just as for the response latency data, a priori contrasts were calculated between congruent and incongruent trials. These comparisons were significant for each of the three levels of the memory load variable. Participants made more mistakes for affectively incongruent prime-target pairs as compared to affectively congruent pairs: *no load*, $M_{\text{congruent}} = 0.18$, $M_{\text{incongruent}} = 0.61$, $t(23) = 2.4$, $p < .05$; *low load*, $M_{\text{congruent}} = 0.22$, $M_{\text{incongruent}} = 0.66$, $t(23) = 2.43$, $p < .05$; and *high load*, $M_{\text{congruent}} = 0.26$, $M_{\text{incongruent}} = 0.52$, $t(23) = 1.7$, $p = .05$.

In addition, the analysis revealed main effects of block, $F(1, 22) = 7.08$, $p < .05$, and target valence, $F(1, 22) = 5.47$, $p < .05$. Less mistakes were made in the second experimental block ($M_{\text{block 1}} = 0.47$; $M_{\text{block 2}} = 0.32$), and when the target was positive ($M_{\text{positive}} = 0.33$; $M_{\text{negative}} = 0.46$).

Finally, there was a less interesting interaction between block, memory load and target valence, $F(2, 44) = 3.35$, $p < .05$, which was difficult to interpret in a straightforward and theoretically meaningful way.

Discussion

Fazio (Fazio, 1990; Fazio & Towles-Schwen, 1999) distinguishes between two classes of attitude-to-behaviour processes. The first is based on a deliberate and conscious reflection of the attitudes relevant to the behavioural decision. The second route is entirely based on spontaneous, automatic processes and consists of two general, subsequent steps. First of all, the observation of an attitude object leads to the automatic activation of the related attitude (positive/negative). Next, this activated attitude serves as a filter that influences subsequent processing of the attitude object in the immediate situation in which it is encountered. By influencing perception in this way, attitudes may have an impact on eventual behaviour, even without the individual's reflecting upon the attitude.

Evidence for the first step in this automatic route (i.e., automatic attitude

⁴ Greenhouse-Geisser corrections (with adjusted degrees of freedom) are applied when necessary (Mauchley's Sphericity Test $< .05$).

activation) is now firmly established by a series of studies employing the affective priming paradigm. These studies show that automatic attitude activation is based on a fast-acting process, which does not require an evaluative goal (intention), is not dependent upon awareness of the activating attitude object and can be generalized to different types of stimuli and tasks. In sum, automatic attitude activation seems to be a fairly general and rather unconditional phenomenon.

However, most affective priming studies took place in a context which was poor of external stimulation. Most often, the room was quiet and dimly lightened, stimuli were presented one by one, trials were separated by relatively long inter trial intervals (3 or 4 seconds) and participants had to perform only one, rather simple cognitive task, i.e., evaluating the target stimulus. This stands in marked contrast with more natural, real life situations in which we are usually confronted with a simultaneous presentation of masses of stimuli that enter our cognitive system via different sensory modalities at a very rapid pace, while usually being engaged in often rather complex cognitive or behavioural tasks. Given that such situations of high mental load are not unusual, one could wonder whether automatic attitude activation is still possible under these conditions.

This has led us to the study of the fourth horseman of automaticity: efficiency. If automatic attitude activation is based on an efficient process, it is predicted that it will operate even when spare attentional resources are scarce. If, however, the automatic attitude activation process by itself requires a certain amount of cognitive resources, it might not show up when attentional demands are high. To test this, we made use of the concurrent memory load technique (Baddeley, 1986). Participants performed a standard affective priming task while simultaneously reciting out loud a series of digits. The extent to which this secondary memory load task depleted cognitive capacities was manipulated over three levels on a within-subjects basis. The results were rather straightforward, as a standard affective priming effect emerged, which was not mediated by the memory load manipulation. This pattern of results emerged in both the reaction time data and the error data. Nevertheless, participants reported highly significant differences in the self-reported mental load for the three memory load conditions.

These results are a first experimental indication for the fact that automatic attitude activation is based on an efficient cognitive process. This has important implications with respect to the ecological validity of the phenomenon. If attitudes would only be automatically activated when attentional demands are low, this would strongly limit the importance of the automatic route of attitude-to-behaviour processes as described by Fazio (1990).

With respect to this conclusion, it has to be noted that the efficiency of automatic attitude activation is concluded from a nonsignificant effect for the critical Memory Load X Affective Congruence interaction, and statistically represents an acceptance of the null hypothesis. Consequently, a critical issue is the sensitivity or statistical power of the critical test. Following a corrected procedure of Cohen's (1988) treatment of power calculations in ANOVA (see Hendrickx, De Houwer, Baeyens, Eelen, & Van Avermaet, 1997 (Appendix)), we therefore calculated the power for the critical F-test, and arrived at values of .175, .830, and .998 for a small ($f = .10$), a medium ($f = .25$), or a large ($f = .40$) effect size, respectively. Hence, unless the effect size of an eventual memory load effect on affective priming would be small, power exceeds Cohen's recommended criterion of .80.

Also, more important than the absence of an interaction between affective priming and the memory load manipulation is the fact that we observed a significant affective priming effect in the high load condition. In fact, in absolute terms, the difference between mean response latencies for affectively congruent and incongruent trials was almost identical for the No Load condition (35 ms) and the High Load condition (34 ms). So, irrespective of the absence of a Memory Load x Congruence interaction, it is important to note that under circumstances of high memory load, which was also experienced as rather difficult, a significant priming effect could still be observed. This warrants the conclusion that automatic attitude activation should not be restricted to situations in which attentional demands are low.

Nevertheless, on the basis of the present study, one can not conclude that automatic attitude activation is *totally independent* of the availability of cognitive resources. This can only be demonstrated when a secondary task would be used that exhausts *all* available resources, and the affective priming effect would still be present. Although participants did indicate that the high load condition produced a very high degree of mental load, there is no doubt that the secondary task did not entirely deplete all cognitive resources. In this sense we would prefer to speak in terms of *relative efficiency*. Future research could be aimed at developing other strategies to get a more detailed view on the degree of efficiency. One possibility would be to make the secondary task even more difficult. Although mean response latencies for the low and high load conditions were about 20 ms longer as compared to the no load condition, there was no significant effect of the memory load manipulation. This could be taken as an indication for the fact that there is still sufficient margin to enhance secondary task difficulty. Hence, future research could be aimed at investigating affective priming under conditions of even higher mental load. One should be cautious however for the fact that increased mean response latencies, due to higher

mental load, could be sufficient to influence the amount of affective priming. Indeed, there is rather good evidence from associative priming research that the strength of priming effects can be dependent upon mean response latencies (Williams, 1996).

Finally, we want to point out that an important characteristic of efficient processes is that they do not interfere with other ongoing behaviour or cognitive processes. This is probably the core of the functionality of having effortlessly accessible attitudes at one's disposal. They are useful in the sense that they increase the ease, speed, and quality of decision making (Fazio et al., 1992), in particular when the situation is complex or when time pressure is high.

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Appendix

Primes

vrede	(peace)
bloesem	(blossom)
boeket	(bouquet)
peuter	(toddler)
zon	(sun)
liefde	(love)
humor	(humour)
kus	(kiss)
wens	(wish)
goud	(gold)
streep	(line)
vierkant	(square)
balpen	(ballpoint)
tas	(cup)
papier	(paper)
raadsel	(riddle)
trompet	(trumpet)
keel	(throat)
bord	(plate)
klas	(class)
ziekte	(disease)
ongeluk	(accident)
vuilnis	(garbage)
puist	(pustule)
angst	(anxiety)
vet	(fat)
paniek	(panic)
verdriet	(grief)
dood	(death)
pijn	(pain)

Targets

charmant	(charming)
gelukkig	(happy)
warmhartig	(warmhearted)
oprecht	(sincere)
dankbaar	(grateful)
behulpzaam	(helpful)
betrouwbaar	(reliable)
warm	(warm)
blij	(joyful)
zacht	(soft)
sociaal	(social)
opgetogen	(elated)
tactvol	(tactful)
volhoudend	(perserving)
avontuurlijk	(adventurous)
vals	(false)
hatelijk	(spiteful)
wreed	(cruel)
gemeen	(mean)
vervelend	(annoying)
brutaal	(bold)
klagend	(lamenting)
egoïstisch	(egoistic)
vijandig	(hostile)
agressief	(aggressive)
laf	(cowardly)
pessimistisch	(pessimistic)
gefrustreerd	(frustrated)
wantrouwig	(suspicious)
jaloers	(jealous)